

# Didactics of the Learning Process

Anderberg, Elsie.

Department of Education, Lund University, Box 199,

SE-221 00 Lund, Sweden

Elsie.Anderberg@pedagog.lu.se

Häggström, Steffen.

Department of Civil and Environmental Engineering,

Chalmers University of Technology, Göteborg, SE-412 96 Sweden

steffen.haggstrom@chalmers.se

Nordquist, Anders.

Office of Administration and Service,

Chalmers University of Technology, Göteborg, SE-412 96 Sweden

anders.nordquist@chalmers.se

# Didactics of the Learning Process

## ***Abstract***

Efforts have been made to develop student skills in the V-programme, and improve earlier pedagogical work in this area. Skills training was integrated into three courses, following a clear structure and progression of levels, in a more visible place in the curriculum. General skills, such as language, communication and problem solving, were complemented with group work with emphasis on group dynamics and self-reflection. Didactic elements designed to train skills were further developed in the project. Teacher teams included language teachers and a behavioural scientist, in order to raise the team's competence. Supervision of language and communication tasks was provided jointly by language and subject teachers. Standard course evaluation procedure were made and supplemented with self-reflection, surveys and in-depth interviews.

Skills training will continue on the V-programme, with explicit commissioning and resource allocation. Students and teachers are clearly positive to skills training integrated in subject courses. There are several indications that these elements also increase depth in subject knowledge.

## **Introduction**

### **Rationale for Change**

For several years, the Civil Engineering programme at Chalmers University of Technology has been committed to provide students during the course of their studies with conscious training in generic skills. These efforts have been undertaken in response to demands made by employers and society for several decades. As the result of a long process to gain support among staff and the Programme Board, the ambition was presented as follows in the goals of the programme (Väg- och vattenbyggnad, 1998). The course shall provide:

- Competence for a sustained professional activity
- Complex problem-solving skills, including the ability to
  - identify basic relations and concepts;
  - analyse and compute;
  - interpret and evaluate;
  - present information orally and in writing.
- Managerial skills and the ability to cooperate and perform tasks in a given framework.

The V-division had for some years been assisted by two pedagogical consultants, who supervised the teachers and helped them work with well-defined goals. Two projects, partly situated in the context of Chalmers pedagogical initiative C-SELT, were particularly relevant to realize the goals outlined above. In *SKILL (Language and Communication in Lifelong Learning)*, communication skills were dealt with comprehensively in an overall effort. Working together with linguists, didactic elements were developed, based on group-based project work integrated in subject courses (Anderberg & Nordquist 2003; Andersson et al, 2003; Anderberg, 2004). The second project, *Scientific Problem Solving* (Hagentoft & Sällfors, 2002), developed a model to solve open complex problems in ways relevant to engineering. Experience resulting from these two projects formed the basis for *Didactics of the Learning Process*.

In accordance with the Bologna agreements, the importance of employability after graduation, and thus the crucial role of skills, is emphasized in Chalmers' new education system.

Skills training integrated in subject courses also support knowledge building and the depth students attain in subject knowledge. It is becoming increasingly interesting to study the connection between knowledge building and integrated skills in different learning situations. How do improved skills impact the students' individual learning strategies?

While skills are now explicitly included in the goals for several programmes, experience indicating how to provide skills training is still insufficient. The educational development project *Didactics of the Learning Process* therefore aims to

- a) reinforce the implementation work which had been initiated earlier by integrating a range of 'didactic elements' for training and teaching skills,
- b) create a progression organised in modules at three different levels in the V-programme at Chalmers and
- c) to support, stimulate and develop knowledge about the learning process, with a focus on skills acquisition, for both students and teachers. We anticipate that this will enhance quality of student knowledge building.

## Review of relevant literature

### *Background*

Academic teaching practices have had a disciplinary focus, and skills have to a large extent been forgotten or considered irrelevant (Harvey, 2000; Bennet et al, 2000). In latter years, however, the improvement of student skills has become a central objective in higher education and work in this area has increased. Briefly, this could be described as a movement from “mission level” to “the real level”, responding to a demand that to a large extent emanates from employers (Allen, Boezeroy, de Weert & van der Velden, 2000), but also from the students themselves (Universities, 1999; Jacobsson 2002; Borthwick & Wissler, 2003;) as well as from teachers.

Skills are clearly linked to learning. Students’ study strategies and approach to learning have been described in terms of deep and surface learning, with a focus on referential aspects, as well as in terms of atomistic and holistic learning, with respect to organisational aspects (Bowden & Marton 1997; Marton & Booth 2000). The differences and connections between these learning strategies have an impact on student knowledge building (Silen, 2000). Bowden (2002) argues that students’ ability for self-reflection and self-assessment is an essential precondition to develop awareness about the importance of developing skills. Students find this difficult, and need the support of a supervisor, mainly because they are unaccustomed to this type of activity (Bennet, 2000 et al, p 71).

### *Terminology*

Confusion in terminology in the area is widespread, and there is no consensus concerning what is meant by ‘skills’, which skills are central, which are necessary, and which are disciplinary. Furthermore, there is no theoretical and conceptual basis that could be used as a point of departure (Bennet, 2000). A great deal of criticism has been expressed regarding the way skills are taught (Hyland 1998). Recent debate on skills acquisition has been lively (for an overview, see Gilbert et al, 2004).

Today a host of different expressions are used to qualify skills, for instance: core skills, key skills, generic skills and personal transferable skills. The terms ‘core skills’ and ‘generic skills’ are often used synonymously, to denote the capabilities to learn, reflect, argue, analyse, solve problems and think critically. The research overview *Higher education and graduate employment* (Löfgren & Martinsson, 2007) gives a more detailed account of the difficulties created by the terminological confusion in this field of research. De la Harpe et al ( 2000) suggest using the term ‘professionals skills’, which includes the skills mentioned above.

### *Teaching practice*

A certain consensus exists regarding the skills students are expected to acquire, whereas methods for teaching and assessment vary (Harvey, 2000). In some countries, students are taught separate ‘key’ or ‘generic skills’ needed to move on to the next level, while in other countries skills training is integrated into subject courses. In the first model, students become more aware of the skills they have acquired than in the second. There is also a middle model, known as the ‘parallel’ acquisition of skills (Harvey, 2005).

Much of current debate has concerned the question whether skills can be acquired in the classroom, or has compared intervention where skills are ‘embedded’, respectively ‘stand

alone'. The 'stand-alone' model has proved less effective, since students fail to perceive the relevance of modules that are only marginally related to disciplinary studies (Cranmer, 2006).

### *Skills and knowledge building*

Teaching practices in higher education are becoming increasingly student-centred, involving, for instance, various forms of PBL, projects, learning groups, student portfolios, etc., where self-directed learning is a central feature. This, in turn, presupposes the acquisition of the skills needed to benefit from these methods of instruction (Silén, 2000. Anderberg, 2004). How skills acquisition forms a precondition for knowledge building is therefore an issue that urgently needs to be addressed.

Students' approaches to learning play a crucial role in knowledge building, and considerable individual variation has been observed. This is why Bowden (2002) proposes a 'capabilities-driven curriculum', to develop skills and provide students with better capabilities to relate to knowledge in varied and productive ways. Bowden feels that universities have neglected to show the impact of academic skills as a fundamental condition for deep knowledge building, whereas surface learning and reproduction do not presuppose the acquisition of academic skills to the same extent.

By 'didactics of the learning process' (Anderberg, 2004) we mean the integration of knowledge and skills as a dynamic interplay, of which the student needs to become aware. This creates better conditions to motivate students, since they have the opportunity to reflect over the function of the skills in their specific context, relating to the particular task they are dealing with. Didactics of the learning process then become a question of how teaching forms and content can be intentionally adapted to this purpose. In other words, how teaching creates the conditions for students to be confronted with the ways learning may vary and change in different learning situations. Hård af Segerstad, Klasson & Tebelius (2000) define the learning process in similar terms, but do not emphasize the learner's perspective on his/her own learning process.

## **Questions**

The project included a number of general questions from the start:

- How can we achieve a long-term reinforcement of the efforts already initiated for the structured integration of skills in V-programme courses?
- How shall we design didactic elements that ensure a progression of increasingly advanced skills in the V-programme?
- In which ways can the didactic elements support, stimulate and develop knowledge relating to the learning process, for both students and teachers?

To some extent, we considered the issue of resources allocated to skills training, versus resources devoted to the actual subject in each course. Initially, there were also many questions concerning the ways to assess student acquisition of skills, and their relevance for the learning process.

## **Importance of the project to you**

For the project management team, consisting of Steffen Häggström, Director of the programme at the time, Anders Nordquist, Programme coordinator, and Elsie Anderberg, pedagogical consultant, the project has served multiple purposes. On the one hand, the team aimed to design course elements for skills training, and integrate these into the programme, in order to educate better performing engineers. On the other hand, it aspired to develop the connection between skills and knowledge building in different subjects.

Achieving a scale of progression in skills acquisition and meeting programme goals (intended learning outcomes) in this area constitute the core of the project, which continues earlier pedagogical development work with positive results.

Participating teachers already had experience working with projects on their courses, and saw the potential of developing and reinforcing this form of instruction, since it leads to an improved quality of knowledge building than traditional instruction with lectures, exercises and examination. An additional priority was to help students develop from competence in solving well-defined problems to skilfully dealing with open problems. All participants felt that integrating skills training into the coursework was positive. We all believe that skills play a key role in the programme as a whole, as well as in the specific courses.

## **Method**

### **Students**

The project concerns students from years 1-3 on the Civil Engineering programme at Chalmers, with a wide range of backgrounds and different initial knowledge levels. Employment opportunities are good, which increases their motivation to study. Many enter the programme directly upon leaving upper secondary school. The proportion of women lies around 25-30%. Forms of instruction are primarily lectures, computing exercises, experiments and project work, including group work and seminars.

The didactic elements for skills training are integrated into the subject courses, and applied to projects and various elements in these. In the basic level courses concerned by the project, most instruction takes the form of lectures and project work.

### **Innovation**

Skills training had previously existed in the form of isolated elements throughout the programme. Elements involving skills training were designed in separate projects which had not been entirely coordinated. Focus had been placed on communication, problem solving and student learning. The elements had no clear progression and were not completely integrated. The students perceived them as minor digressions from the main topics. Furthermore, the relation existing between skills training and knowledge building was not clarified.

Curriculum units affording skills training were placed in the context of student projects in groups, a form of instruction the students had encountered on several occasions before entering the Civil engineering programme. Nevertheless, this form of work proved to be problematic for the students. The students' and teachers' awareness of groups and group processes was not as developed as anticipated. Benefits that students gained from their work were therefore also less than expected. An additional skill, the ability to work in groups, needed to be improved and integrated. It was also considered essential to introduce an element of self-reflection. The vision was to create a cohesive plan for integrated skills training throughout the programme, presenting a clear scale of progression for both teachers and students.

Earlier educational development projects have shown that communication skills training is more effective when the team of teachers for technical subjects also includes language teachers. Working with multi-disciplinary teacher teams has therefore been an important factor for successfully carrying out the project. This means that language teachers, the behavioural scientist and teachers of technical subjects, together plan, carry out and follow up the courses. During the project, the teacher teams received support from an educational developer at seminars, as well as supervision. On these occasions, focus was placed on the learning process and on supervising both the group process, and training communication or problem solving. The teachers' personal experience was used as a point of departure, which was then discussed and put in relation to pedagogical theory. By raising competence levels, the teachers were able to take greater responsibility for the course.

Two student representatives participated in project meetings and seminars. All students who attended the courses were engaged in evaluations and reflection tasks, while some were additionally interviewed. Comments from all students participating in the three modules have been received, through continuous course evaluations according to the standard model applied in the programme, as well as through project-related reflection tasks.

### **Building in society (Year 1)**

Teachers from various technical fields work together with language teachers and a behavioural scientist in the course *Building in society*, which is the introductory course of the programme, attended by some 120 students. The students' ability to work effectively in a group, as well as their oral and written communications skills are introduced as learning objectives already at this stage, and followed up in other courses during the programme.

Several field visits to workplaces provide insights into the professional role of engineers, and introduces a holistic perspective in the areas of study of the programme (Civil Engineering: Construction, Transport and Water). The introduction has been designed to show the width of applications covered by the programme and the diversity of future employment possibilities, which effectively prevents students from abandoning their studies at an early stage. The introductory course also fosters a sense of security, allowing students to familiarise themselves with subject matter, teaching staff, the structure of studies and information flow.

The course is offered during the two study periods of the autumn semester in the form of projects, where the main part of the work is performed in groups. Interventions from a behavioural scientist support the group work. As a complement to the project work, a series of lectures introduce the project, support students' work with the task, and provide a comprehensive view of the programme. The module is divided into several units, which run parallel with different weekly topics. The results from each unit are the point of departure for a section in a summarising project report. Project work is presented in two stages, and supervised by subject teachers and linguists. The work is presented orally and in writing halfway through the course, and students receive both written and oral feedback from subject and language teachers, as well as advice on how to continue. The course finishes with a conference, where the project group presents their work orally, hands in a report, discusses the work of another group, makes a poster to present the construction they have studied, and writes a personal reflection. Examination takes place in connection with the conference, considering all the tasks listed above, and the outcome is discussed with each group.

The projects in V1 were carried out in groups of 4-5 students. Students were divided into groups by teachers responsible for the course. At the beginning of the course, the entire student group received an introduction to the basics of group dynamic processes, including group dynamic exercises. When the students had been working in their groups for some time, they were asked, against the background of this knowledge, to write an individual reflection on their own role and how the group functioned, analysing how the progression of their project work was affected. They received written feedback on this assignment. The individual assignment was then linked to an exercise where each group was requested to jointly write about group dynamics and their project, and finally, their reflections were discussed with the behavioural scientist.



## **Environmental and resource analysis for sustainable development (Year 2)**

The course *Environmental and resource analysis for sustainable development* is taught to a group of approximately 110 students in Study period 1 of the autumn semester in parallel with the module Mathematical multiple variable analysis. The module *Information competence V* is given as an integrated part of the module.

Four teachers come from the Department of Environmental systems analysis: one main lecturer, who is responsible for the course and also serves as examiner; and three doctoral students who together with the examiner direct exercises and supervise the subject. These four teachers, together with an additional 2-4 language teachers, make up the teacher team.

The module consists of two parts. The first comprises lectures, teacher-directed exercises and written examination. The second part is a supervised project, integrating lectures on writing processes and supervision of these processes. The project culminates with a written report, combined with an oral presentation and discussion.

The projects were carried out in groups of 4 students, where students chose subject area and composed groups themselves. After they had completed the project work, students were given the opportunity to reflect on how the developments in the group had affected the accomplishment of their project tasks.

In the group work, each group makes in-depth studies of a particular issue within sustainable development, an aspect frequently encountered by civil engineers specialised in construction, transport and water in their professional life. The task consists in comparing two technical systems with a similar function. The students choose groups themselves, and decide which area they prefer to work with: sewage, waste management, heating houses or transport systems.

The didactic elements commence with an introduction to the task, and groups draft an outline assisted by supervisors. During the project work, a course on the library data bases is given by Chalmers' library (*Information competence V*), as well as a lecture series on the writing process, report-writing and oral presentation. Approximately halfway through the project period, students hand in a draft version of their report, and a few days later get 20-25 minutes' supervision per group with their subject supervisor and a language teacher. The rest of the time, subject supervisors are often available to answer questions.

The subject teacher and language teacher jointly provide supervision during a special lesson relating to the preparation of the presentation and discussion. They also attend the presentations given at the last day of the course. After presentations, oral feedback is given to each group. Students can also request oral or written feedback on their report.

## **Technical urban planning (Year 3)**

The course deals with road and traffic planning in society. Forms of instruction are lectures, exercises and project work. The objective is for students to learn and apply a model to solve open problems. The model for solving open problems was developed in an earlier pedagogical project, *Scientific Problem Solving* (Hagentoft & Sällfors, 2002).

The first time the course *Technical urban planning* was taught including problem solving as an integrated element, the module was optional, placed in the third study period of Year 3.

The next time the module was taught, it had become compulsory for all students on the V-programme, and had been moved to the first study period of Year 3. The first year the course was taken by about 55 students; and half a year later by about 120.

The set up differed for these two occasions. A single teacher carried out the exercise on Occasion 1, whereas a total of four teachers participated in Occasion 2. Also, the problem-solving method itself was focused more clearly on Occasion 2. An additional difference was that Occasion 2 included a practical task, where the students went in groups on a field visit to study a road segment, in order to compare their model with reality. After the exercise, the students were given the opportunity to reflect individually in writing on the exercise, and consider how it had influenced their learning and understanding of the way roads are designed. On Occasion 2, only the design of the road was dealt with, whereas on Occasion 1, the localisation of the road was also included. A written examination ended the course. Completing the problem-solving task and the project assignment were requirements to sit the exam.

## **Evaluation**

We used several types of evaluation on these courses, and these differed somewhat between courses. The course evaluation procedure of the V-programme was used, involving three evaluation meetings with a group of students. The first meeting is held in study week 1, the second in study week 4, and the third after the presentations and the end of the courses in study week 8. Minutes are taken at all meetings, and a final document is drafted by the students. A second type of evaluation was used where students wrote individual reflections in connection with supervision or/and at the end of their project. The third type of evaluation consisted of a survey at the end of the course. In-depth interviews were conducted with some students on two different occasions, one year apart.

## Results

### Outline of results

The content and progression of the skills taught in the project are summarised in the table, based on the model developed by Serkitjis et al (2007). A solid basis already existed in the V-programme and was further developed in the project. Our experience indicates that efforts to enhance student skills will continue to be integrated in subject courses.

A long-term plan has now been drafted for the entire programme, specifying when and how skills are trained in the courses. This means that three courses have been granted extra resources to carry out skills training. Additionally, skills are applied in several other modules. In the frame of the project *Didactics of the learning process*, we worked both to systemise skills training, and ensure a progression over the three courses. (Johansson, 2007; Molander et al, 2007; Serkitjis et al 2007). Elements affording skills training have been further developed during the project. The three modules providing core aspects of skills training are *Building in society*; *Environmental and resource analysis for sustainable development* and *Technical urban planning*.

		Year 1	Year 2	Year 3
Written	Reporting	Explorative and summarising report; based on information from the construction industry of varying quality.	Comparative analysis; based on material from scientific articles, policy documents, regulations and laws.	Presentation of model elaborated by the group.
	Visualisation	Combining text and image into an effective whole, that complements the report and presentation. Well-functioning selection of information, poster and power-point.	Visualisation rather than illustration, meaning that the visual material to the greatest extent possible should be visual rather than textual.	Visualisation in the form of the presentation of personal ongoing work-in-progress “draw and show” (has not been emphasized within the project).
Oral	Presentation	Oral presentation of the actual results in the study undertaken. Differentiating between content and structure in report and oral presentation.	Identifying arguments and forming an opinion about the problem / issue presented in the report.	Presenting and discussing thoughts about the group’s model “draw and tell” (has not been emphasized within the project).
	Dialogue	Pose questions on content in another report and attempt to create a dialogue with the authors, in a way that is relevant to session participants.	Create and participate in an active dialogue about the issues raised in the group’s own report, as well as other reports. Relevant opinions should be presented and other students’ opinions concerning the group’s text should be dealt with in a distanced fashion.	Examine and discuss the work of other students using models (has not been emphasized within the project).

Group work	Knowledge and awareness of group dynamic processes; achieved through a combination of subject knowledge, practical experience and feedback.	Developing knowledge and experience of working in freely composed groups.	Practising group work (has not been emphasized within the project).
Problem solving	Studying an object involving a connection between purpose and design.	Analysing 'half open' problems without a given answer, by weighing the pros and cons of two alternative approaches.	Working with an open real-life problem. Systematic problem solving, analysing steering phenomena, sorting out the most important of these and using them to develop a model, which is then applied to reality in an iterative process.
Self-reflection	Reflection on the student's own contribution and interaction with others in the group, as well as the issue of how this influences working with the task.	Further reflection on the interaction between personal work, group processes and the overall work process, including influence on the student's learning.	Reflecting on how the problem-solving model and related work have influenced learning subject matter.

The presentation of results follow our goal description

- a) reinforce the implementation work which had been initiated earlier by integrating a range of 'didactic elements' for training and teaching skills,
- b) create a progression organised in modules at three different levels in the V-programme at Chalmers and
- c) to support, stimulate and develop knowledge about the learning process, with a focus on skills acquisition, for both students and teachers. We anticipate that this will enhance quality of student knowledge building.

*a) Reinforcement of the implementation of skills in the V-programme*

The conditions are very favourable for skills training, in the form presented in the table above, to be included in the V-programme in the coming years. The objective of progression in skills acquisition is included in the plan for the programme. Skills occupy an important position in intended learning outcomes according to the Bologna system.

The V-programme already contained a number of didactic elements for skills training. These have been further developed and complemented. Instead of earlier separate courses, extra resources have been allocated for skills training activities integrated into subject courses. The education development project *Didactics of the Learning process* has been conducted in close cooperation with the Director of the programme, who also participated in the project. Skills training in the programme will be improved and a progression in the masters programmes will be developed.

Participating teachers have reacted favourably, and wish to pursue their work on skills acquisition in the same spirit. Student evaluations, reflections and interviews show an equally positive attitude. The fact that courses in the project were generally taught by teacher teams helped to spread the experience, and reduced dependence on individual teachers.

Seminars and literature studies relating to group supervision, knowledge building and skills acquisition have increased teacher competence in the area, and will hopefully contribute to spreading knowledge to others.

*b) Progression of skills in the V-programme*

The table shows how communication, group work, self-reflection and problem-solving skills are progressively developed during the programme. Specific training interventions are made in the modules included in the project. However, skills are naturally trained and applied in other modules as well. Additional efforts are made in connection with the Bachelor's thesis, and later in the Master's programmes.

*Communication and language*

Students' written reports progress from a descriptive to a more analytic type of content. Oral presentations develop from the simple description of results, to presenting relevant analyses and reflections on their own and others' work, as well as participating in dialogues.

Supervision and feedback on reports and presentations have consistently been made jointly by a linguist and a subject teacher. We believe that this adds weight and credibility to how skills are integrated in a way perceived as meaningful by students and teachers, particularly

concerning language and communication skills. Supervision and feedback takes place on several occasions during students' work with reports, presentations and discussion.

The linguists engaged on courses in the first and second years of study, V1 and V2, see a clear development of the ability to write reports, present arguments and make different types of presentation.

### *Self-reflection*

The reflection tasks are altogether new elements in the courses. They were included to make students aware how their skills develop and realise that skills are needed to benefit from the instruction that is offered. Teachers' reports show that there is a positive student consensus, apparent above all in reflection tasks and in-depth interviews, to increase awareness of the relevance of skills.

In the in-depth interviews this mainly concerned group work experience, in particular the importance of creating improved commitment, in order to achieve well-functioning groups, able to work on tasks in a dedicated manner, but also an awareness of the importance of their own involvement and taking greater responsibility for it.

In their reflection assignments students primarily express an involvement and their ability for reflection. The nature of reflection varies. Some are more synthetic, whereas others are more detailed. Some clearly display how students relate to their own learning, and a certain extent of self-assessment can be observed.

### *Group work*

The ability to work in groups is a skill that was not mentioned explicitly in our project proposal. According to our project design, the various didactic elements for skills training were carried out in groups. At an early stage, we discovered how important it was that the actual group work functioned well, allowing students to benefit from this design. This meant that the students need knowledge and skills relating to group dynamic processes. We therefore added elements dealing with group dynamics in the context of the group's own work.

Students became aware of how groups work, something which facilitated the group's development. They also realised that the group is a resource to gain their goals and to build knowledge. Our experience involving a behavioural scientist to work with group dynamics are excellent, using the course design presented earlier in "Method". The teachers' impression was that the group work functioned well. A difference was that some groups in V1 split the work into individual sub-tasks that were then put together, whereas in V2 it seemed that participants were involved with all parts of the task, showing a clear progression of group work.

### *Problem solving*

Problem solving is a natural feature of most courses. Which teacher at a civil engineering programme is able to claim that he/ she does not deal with problem solving in their courses? At the beginning of studies, problems tend to be well-defined and delimited; while towards the end of studies they become more applied and realistic engineering problems, of a more open type.

The problems treated in the project courses follow this pattern, working with a well delimited problem / task in V1, and a half-open problem in V2, where identifying and delimiting the problem is part of the task. In these courses no particular efforts are made that focus problem solving as such. In V3, students are presented with an open problem, and introduced to problem solving methods, involving the analysis of steering phenomena, simplification, designing a model that is applied to reality in an iterative process. The approach was developed by Hagentoft & Sällfors (2002). The students made reflection assignments after completing this task. They stated that they would have liked to be introduced to problem solving at an earlier stage of their studies, and that this element provided them with a deeper understanding of subject matter. For instance, two students wrote:

*"The exercise was very good for building understanding about the standards and also the design of the road. All the factors which we found were actually those the standards were based on, and that was not something we had thought about at the beginning. Because we isolated the factors that govern the standards through our own reflection, I think it was easier to understand the standards than if we had started with them directly. If you understand the background to the norms and the standards, you also understand how the road is designed."*

*"When we were working with the project task, the students in our group realised that the model was a good way to deal with an open problem ... At the outset, the connection between road geometry and the model felt somewhat contrived, but the more we worked with the project, we came to see that it fit the task at hand very well, and that we thereby developed our understanding for the model and its areas of application."*

Teachers were also positive throughout, and will further develop this element for next year.

#### *c) Supporting and stimulating teachers and students in skills acquisition and the learning process*

Teachers get a good basis for working with skills by working in teams composed of subject teachers, linguist and a behavioural scientist. They are all involved in planning, teaching and following up the course. One of the effects is that all teachers participate in discussions relating to various elements, thereby gaining a comprehensive view of the course. However, the module Technical social planning was not organised in this way.

Within the framework of the project, all involved teachers participated in seminars and discussion, on the topics knowledge building, group supervision and skills acquisition. Participating doctoral students also were offered personal supervision and credits for their participation in the project, corresponding to doctoral coursework. During the whole project the teachers were enthusiastic.

The students were given information on the project and its purpose at the commencement of each course. They received continual instruction and supervision relating to the different skills, as well as feedback on reports, presentation, discussions, group work and problem solving. Self-reflection provided additional opportunities to put the skills in a relevant context and gain insights in how they related to knowledge building.

## **Discussion**

### **Analysis**

The purpose of the project was informed by experience from previous pedagogical renewal projects in the V-division. The didactics of the learning process (Anderberg, 2004) is compatible with Cranmer's (2006) description of 'embedded' skills training, and is inspired by Bowden's (2002) view that clearer connections to professional practice after graduation is necessary. Additionally, the project has stressed the relevance of skills development to stimulate qualitative improvements in knowledge building, and accentuate students' awareness of the role of skills and insights into their own learning processes.

Results indicate notable progress in the unit with respect to group cooperation, and awareness of consequences on work and learning. There are continued needs to reinforce progression in this, focusing group leadership. Above all, reactions from both students and teachers concerning the need for well-functioning groups are positive, calling for new course elements to enhance knowledge about group processes and elements that focus increased awareness of the interaction between group processes and learning processes. It was not possible to achieve optimal progress in this area, since students also needed additional knowledge about learning and knowledge building. We had initially planned a lecture which could not be held, due to insufficient time in the frame of the course.

Communication, argumentation and critical examination have been reinforced and continue to receive positive reactions. Introducing reflection and self-reflection aimed at raising student awareness of the function of skills for their learning and knowledge building. It has therefore served as a basis for assessment. These efforts will continue and need to be developed to become more self-evaluating, in order to achieve the purpose. In the future, it is also essential to pay attention to how progression in self-evaluation can be made at different levels of the studies, bringing additional focus to the interaction between group processes, working processes and learning processes.

### **Implications**

Skills training is introduced in the programme following a well-defined structure and scale of progression that closely agrees with the programme goals for skills. Adequate information to teaching staff allows skills to be consciously applied to the other courses of the programme as well.

The involvement of the student guidance officer in the group process increases natural contacts with students, thereby facilitating study guidance.

For modules that are part of the project, skills training elements were designed to be integrated in coursework, while at the same time appearing as distinct interventions with clear goals. These elements were also felt to enhance subject studies, by affording greater learning depth.

### **Conclusions**

The V-programme should continue to invest in skills training by explicitly commissioning training elements, and allocating resources to these. We are convinced that teacher teams



should include individuals with competence in areas where the subject teachers are clearly limited, such as languages, communication and behavioural sciences. Supervision means that each student feels 'noticed', and interacts both with other students and the teachers. This enhances the students' social development in the programme, and probably reduces the number of students interrupting studies.

Besides those skills that are normally considered, we estimate that working in groups and self-reflection are areas that merit additional efforts, to develop students and raise their awareness of the learning process. The relation existing between students' skills acquisition and the quality of their knowledge building has not been demonstrated within the frame of the present project. This would have required analysis of student project reports and comparison over time, something the scope of the project did not allow. However, this could be a future development project of great interest.

Collected experience from this renewal project leads us to believe that besides the knowledge and experience we have attained concerning how to develop skills and student motivation for skills training, the work on skills acquisition has also meant improved knowledge building, and a better preparation for students' future professional life.

## References

- Anderberg, E. (2004). *Lärprocessens didaktik i ljuset av några erfarenheter från pedagogiskt förnyelsearbete i högre utbildning*. Pedagogiska uppsatser 2004:39. Pedagogiska institutionen, Lunds universitet.
- Andersson, K., Anderberg, E., Hood, E., Johansson, A-M., & Nyström, A. (2003). *Integrating content and language - A successful partnership across disciplines*. Paper to be presented at the conference Developing Language and Communication in Higher Education: Trends in Teaching and Research, Göteborg, June 16-18.
- Anderberg, E. & Nordquist, A. (2003). *Delprojekt SKILL V – Väg- och vattenbyggnad*. Göteborg: Chalmers tekniska högskola
- Bennett, N., Dunne, E., Carré, C. (2000). *Skills development in higher education and employment*, Society for Research into Higher Education & Open University Press, Buckingham.
- Bowden, J. (2004). Capabilities-driven curriculum design. In C. Baillie & I. Moore (Eds.), *Effective Teaching & Learning in Engineering*, pp 36-48. London: Routledge Falmer.
- Bowden, J. & Marton, F. (1998). *The university of learning. Beyond quality and competence*. London: Kogan Page.
- Cranmer, S. (2006). Enhancing graduate employability: best intentions and mixed outcomes. *Studies in Higher Education*. Vol. 31, No.2, pp. 169-184
- De la Harpe, B., Radloff, A., & Wyber, J. (2000). Quality and Generic Professional Skills. *Quality in Higher Education*, Vol. 6, No. 3
- Hagentoft, C-E., Sällfors, G., (2002). *Scientific Problem Solving – A Vital Part in the Undergraduate program*. Chalmers grundutbildningskonferens 2002. Göteborg 2002.
- Harvey, L. (2000). New realities: The relationship between higher education and employment. *Tertiary Education and management* 6, pp. 3-17
- Harvey, L. (2005). Embedding and integrating employability. *New directions for institutional research* 128, pp. 13-28
- Hård af Segerstad H. Klasson, A. & Tibelius, U. (2000). *Vuxenpedagogik. Att icentsätta vuxnas lärande*. Lund: Studentlitteratur.
- Johansson, A (2007) *Erfarenheter från en övning i att identifiera och lösa öppna problem med tillämpning inom geometrisk utformning av vägar*". Institutionen för bygg- och miljöteknik. Avdelningen för geologi och geoteknik. Grupp väg och trafik. Chalmers tekniska högskola. Rapport 2007:22. Göteborg 2007.

Löfgren Martinsson, M. (2007). *The relation between HR education and work in terms of employability*. Paper presented at NERA's congress in Turku, Finland, March 15-17.

Marton, F. and Booth, S. (1997) *Learning and awareness*. New Jersey: Erlbaum Associates.

Molander, S., Börjeson, F. C., Eriksson, A-M., Erlandsson, J., Jonasson, K., & Rex, E. (2007). *Djupinläring genom koppling av kunskapsinläring och färdighetsövning - utveckling av kursmoment i "Miljö- och resursanalys för hållbar utveckling V2"*  
ESA rapport 2007:12, Miljösystemanalys, Energi & miljö, Chalmers tekniska högskola, 2007.

Serkitjis, M., Börjeson, F. C., & Eriksson, A-M. et al (2007). *Integrering av språk, kommunikation, gruppdynamik och informationssökning på civilingenjörsutbildningen - implementering av didaktiska moment i introduktionskursen "Byggande i samhället"* på Chalmers Väg- och vattenprogram

Silén, C. (2000). *Mellan kaos och kosmos. Om eget ansvar och självständighet i lärande*. Diss. Linköping: Univ.

Väg- och vattenbyggnad, (1998), *Mål och strategier för V-sektionen*, Chalmers. Chalmers, Göteborg 1998. (<http://www.vsect.chalmers.se/pdfdokument/malostrategi.pdf>)